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DATA VALIDATION AND STATISTICAL EVALUATION OF DECEMBER 2009 GROUNDWATER QUALITY DATA

CITY OF HELENA LANDFILL

Prepared For:

CITY OF HELENA
HELENA, MONTANA



Hydrometrics, Inc.
consulting scientists and engineers

MARCH 2010

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March 16, 2010

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Environmental Science Specialist
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Dept. of Enviro. Quality
Waste & Underground
Tank Management Bureau

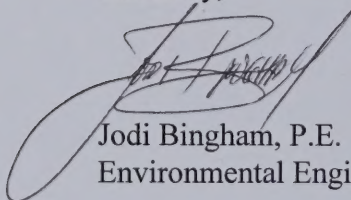
RE: Statistical Evaluation of December 2009 Groundwater Quality Data

Dear Martin,

On behalf of the City of Helena, Hydrometrics validated and statistically evaluated groundwater quality data for samples collected at the City's municipal landfill in December 2009. After receiving approval from Ben Sautter of the City of Helena, I am forwarding a copy of the report "Data Validation and Statistical Evaluation of December 2009 Groundwater Quality Data City of Helena Landfill" for your review.

If you have any questions concerning this report, please don't hesitate to call.

Sincerely,



Jodi Bingham, P.E.
Environmental Engineer/Chemist

Enclosure

c: John Rundquist, City of Helena, without Enclosure
Ben Sautter, City of Helena, without Enclosure
Mike Wignot, Hydrometrics, without Enclosure

**DATA VALIDATION AND STATISTICAL
EVALUATION OF DECEMBER 2009
GROUNDWATER QUALITY DATA**

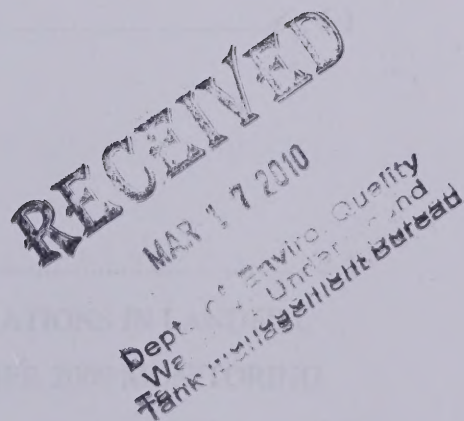
CITY OF HELENA LANDFILL

Prepared for:

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City/County Building
316 North Park Avenue
Helena, MT 59623

Prepared by:

Hydrometrics, Inc.
3020 Bozeman Avenue
Helena, MT 59601



March 2010

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DATA VALIDATION AND STATISTICAL EVALUATION OF DECEMBER 2009 GROUNDWATER QUALITY DATA CITY OF HELENA LANDFILL

1. REPORT OBJECTIVES

This report is prepared on behalf of the City of Helena Landfill to fulfill the groundwater data evaluation requirements provided in Administrative Rules, Montana (ARM) Title 17, Chapter 50. This report provides analytical results for groundwater samples collected at monitoring wells during the December 2009 monitoring event, summarizes, the data validation results and statistically evaluates the data. The samples were collected and analyzed in accordance with the Montana Department of Environmental Quality (MDEQ) approved sampling and analysis plan (Hydrometrics, 2008).

ARM 17.50.708(12) and ARM 17.50.708(13) stipulate the types of statistical data evaluations to be performed on groundwater quality monitoring data from regulated landfills. Federal guidance on conducting statistical evaluations of groundwater data is also available (EPA, 1989; EPA, 1992). These regulations and guidance documents allow the use of a wide range of statistical procedures including: parametric analysis of variance, non-parametric analysis of variance, tolerance or prediction interval testing, trend tests, or other statistical tests meeting the statistical testing objectives of the rules.

Statistical evaluations have been performed for this site semiannually since 1993 and the following conclusions have been reached based on the results of those evaluations:

- Chlorinated hydrocarbons occur downgradient of the landfill;
- Tetrachloroethene (PCE) is the chlorinated organic compound of greatest concern due to Maximum Contaminant Level (MCL) exceedances;

- These findings are further evaluated in this December 2009 statistical report through an assessment of current concentrations (Table 3-1), a comparison of summary statistics (Tables 3-2 and 3-3), an inter-well prediction analysis (Table 3-4), and an examination of temporal trends (Table 3-5 and Figures 3-1 and 3-2).

2. SITE DESCRIPTION

2.1 PHYSICAL FEATURES

A site location map is provided in Figure 2-1. The landfill is surrounded for several miles in all directions by residential, commercial and industrial zoned property. There are several businesses upgradient of the landfill, which have the potential to affect groundwater quality in the area.

A site plan is shown on Figure 2-2. The landfill is divided into three sections. The southern part of the landfill (Phase I and Phase II sections) is unlined and was in operation until the early 1980s. The northern part of the landfill (Phase III) is also unlined, and was in operation until November 1993. The Phase III landfill has been capped with an 18-inch clay cover to minimize surface water percolation through the landfill and subsequent migration of chemicals into groundwater.

2.2 WELL LOCATIONS

Fourteen monitoring wells located around the landfill are typically included in the groundwater monitoring program and are characterized as follows:

- Background wells: HL-06-1 (replacing 83-6), HL-94-1R, HL-94-2R, MPC-5;
- Downgradient wells: HL-90-1, HL-90-2, HL-90-3, MPC-1, MPC-2,
EPA-1, HL-99-1, HL-99-2, HL-99-3; and
- Cross-gradient well: HL-94-3.

As discussed in Section 2.4 and in accordance with the approved sampling and analysis plan (Hydrometrics, 2008), only seven of these wells were included on the sampling schedule for the December 2009 sampling event. Well HL-99-1 was not sampled due to a failure of the dedicated pump in that well; this pump is scheduled to be replaced this spring. Due to vandalization of well HL-94-2 during the previous summer, this well was redrilled in early December 2009 just to the east of the previous location and named HL-94-2R. The locations of these wells are shown in Figure 2-2.



**LANDFILL
LOCATION**



NO SCALE

CITY OF HELENA LANDFILL
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EVALUATION OF DECEMBER 2009
GROUNDWATER QUALITY DATA

VICINITY MAP

FIGURE

2-1



SITE CODE	DTWL	MPE	SWL
Dec-09			
HL-06-1	17.82	3993.62	3975.80
82-3	67.06	3973.51	3906.45
EPA-1	47.68	3981.08	3933.40
EPA-4	70.57	3973.83	3903.26
HL-90-1	58.01	3942.48	3884.47
HL-90-2	50.26	3950.96	3900.70
HL-90-3	61.73	3958.29	3896.56
HL-94-1R	58.60	3994.04	3935.44
HL-94-2R	34.35	3967.64	3933.29
HL-94-3	36.57	3967.38	3930.81
HL-99-1	58.12	3943.15	3885.03
HL-99-2	59.14	3945.75	3886.61
HL-99-3	54.57	3948.05	3893.48
INF. GALLE	7.15	3918.89	3911.74
I-1	65.38	3899.59	3834.21
MPC-1	23.50	3946.08	3922.58
MPC-2	17.24	3936.09	3918.85
MPC-5	56.32	3990.14	3933.82



SCALE

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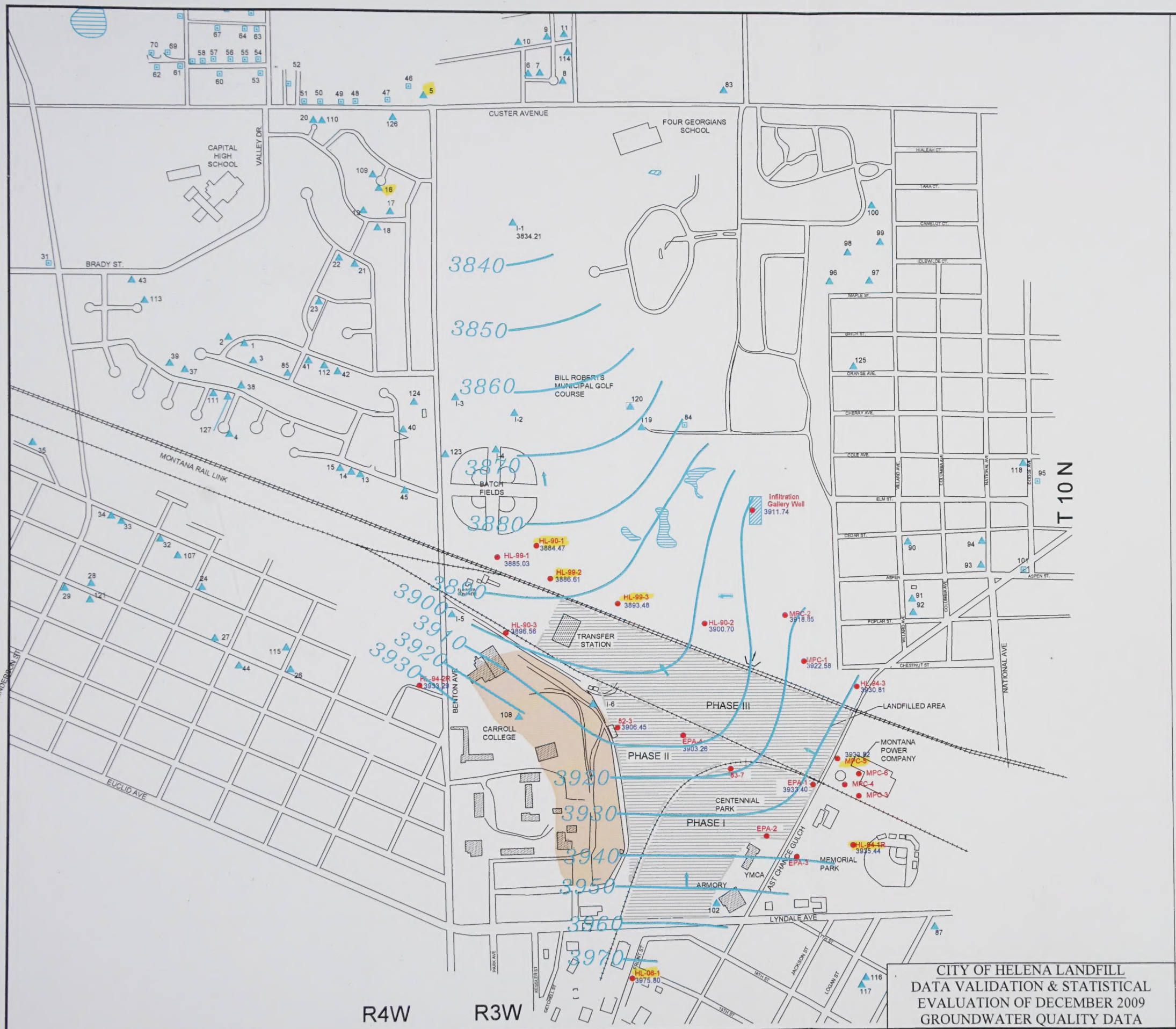
LEGEND

- HL-1 ■ PIEZOMETER
- 83-6 ● MONITORING WELL
- I-6 ▲ IRRIGATION WELL
- 80 □ DOMESTIC WELL
- INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)
- AREA OF SHALLOW LOW PERMEABILITY BEDROCK
- POTENTIOMETRIC CONTOUR LINE
- INFERRED GROUNDWATER FLOW DIRECTION
- STORM WATER OUTFALL FOR LAST CHANCE GULCH

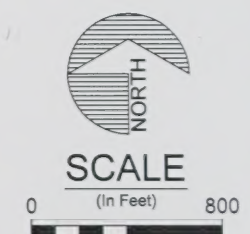
STUDY AREA AND DECEMBER 2009
POTENTIOMETRIC SURFACE

FIGURE

2-2



SITE CODE	DTWL	MPE	SWL
Dec-09			
HL-06-1	17.82	3993.62	3975.80
82-3	67.06	3973.51	3906.45
EPA-1	47.68	3981.08	3933.40
EPA-4	70.57	3973.83	3903.26
HL-90-1	58.01	3942.48	3884.47
HL-90-2	50.26	3950.96	3900.70
HL-90-3	61.73	3958.29	3896.56
HL-94-1R	58.60	3994.04	3935.44
HL-94-2R	34.35	3967.64	3933.29
HL-94-3	36.57	3967.38	3930.81
HL-99-1	58.12	3943.15	3885.03
HL-99-2	59.14	3945.75	3886.61
HL-99-3	54.57	3948.05	3893.48
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- LEGEND**
- HL-1 ■ PIEZOMETER
 - 83-6 ● MONITORING WELL
 - I-6 ▲ IRRIGATION WELL
 - 80 □ DOMESTIC WELL
 - INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)
 - AREA OF SHALLOW LOW PERMEABILITY BEDROCK
 - 3900 — POTENTIOMETRIC CONTOUR LINE
 - INFERRED GROUNDWATER FLOW DIRECTION
 - ⏏ STORM WATER OUTFALL FOR LAST CHANCE GULCH

CITY OF HELENA LANDFILL
DATA VALIDATION & STATISTICAL
EVALUATION OF DECEMBER 2009
GROUNDWATER QUALITY DATA

STUDY AREA AND DECEMBER 2009
POTENTIOMETRIC SURFACE

FIGURE
2-2

2.3 GROUNDWATER FLOW DIRECTION AND VELOCITY

Figure 2-2 shows water level elevations observed in December 2009 and groundwater potentiometric surface contours. Groundwater flow direction is also shown on this figure. The general groundwater flow direction in the vicinity of the landfill is to the north-northwest. The potentiometric surface in the area of well HL-94-3 suggests that groundwater flows to the west northwest (Figure 2-2); thus, well HL-94-3 is not considered to be upgradient or downgradient of the landfill. Well HL-94-3 has, therefore, been designated as a “cross-gradient” well.

Table 2-1 shows the groundwater velocities calculated for each of the monitoring wells sampled during the December 2009 sampling event. Slope was determined from the potentiometric contours shown in Figure 2-2. The hydraulic conductivities were obtained from the groundwater flow model inputs included in the report “Evaluation of Groundwater Extraction Remediation Alternative at the Helena Landfill” (Hydrometrics, 1999a). The porosity for each well was assumed to be 0.25. An average regional gradient of 0.0236 ft/ft was determined between monitoring well HL-06-1 and I-1. This yields an average regional velocity of 0.698 ft/day.

TABLE 2-1. GROUNDWATER VELOCITIES

Well	Hydraulic Conductivity (ft/day)	Slope (ft/ft)	Velocity (ft/day)
HL-06-1	0.03	0.0354	0.00425
HL-90-1	20	0.0198	1.58
HL-94-1R	2.8	0.0119	0.133
HL-99-2	20	0.0187	1.50
HL-99-3	20	0.0120	0.960
MPC-5	2.8	0.0263	0.295

2.4 SUMMARY OF DECEMBER 2009 DATA VALIDATION REPORT

Seven monitoring wells around the landfill and two domestic wells were included in the December 2009 sampling event. The monitoring sites for this event for the City of Helena Landfill include the following:

- Monitoring wells HL-06-1, HL-90-1, HL-94-1R, HL-99-1, HL-99-2, HL-99-3, MPC-5; and
- Domestic wells 5 and 16.

Well HL-99-1 was not sampled due to failure of the dedicated pump in that well. Analytical parameters included metals, volatile organics, semi-volatile organics, halogenated organics, and major anions for the monitoring wells and volatile organics, semi-volatile organics, and halogenated organics for the domestic wells as specified in the approved sampling and analysis plan (Hydrometrics, 2008). In addition, to obtain a complete potentiometric map, static water levels (SWL) were obtained from nine additional monitoring wells, an irrigation well, and the infiltration gallery. The SWL sites for the latest sampling event include the following:

- Monitoring wells 82-3, HL-06-1, EPA-1, EPA-4, HL-90-1, HL-90-2, HL-90-3, HL-94-1R, HL-94-2R, HL-94-3, HL-99-1, HL-99-2, HL-99-3, MPC-1, MPC-2, MPC-5;
- Irrigation well I-1; and
- The infiltration gallery.

The water samples collected for the City of Helena Landfill in December 2009 have been validated by the Hydrometrics' Data Validation Department in accordance with the project work plan, "Revised Sampling and Analysis Plan, City of Helena Landfill, Groundwater, Surface Water and Landfill Gas Monitoring Activities" (Hydrometrics, 2008). Lab and field quality control procedures were appropriate; quality control (QC) samples included a field duplicate (collected at HL-94-1R), a trip blank, a rinseate blank, and standard internal laboratory QC samples. No parameters were reported as above the reporting limit in the trip

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3. STATISTICAL DATA EVALUATION AND COMPARISON

Four types of data evaluations were conducted using the December 2009 sample results for the six monitoring wells sampled in the vicinity of the landfill. The two domestic wells are evaluated separately in Section 4. The four types of data evaluations conducted are:

1. Comparisons of applicable water quality criteria and upgradient (also called “background”) water quality with summary statistics of downgradient concentrations for December 2009 and all samples to date;
2. Inter-well prediction interval analysis;
3. Trend analysis; and
4. Temporal concentration plots.

The first three analyses include all those parameters for which results were reported above the detection limit in any of the six monitoring wells for the December 2009 sampling event.

The fourth evaluation, temporal concentration plots, was performed for PCE and nitrate, the only constituents that currently exceed their regulatory limits in downgradient wells. Data from all wells which have historically shown PCE results above the detection limit of 0.001 mg/L and nitrate results above the MCL of 10 mg/L or with potentially increasing trends were evaluated.

3.1 DOWNGRAIENT WATER QUALITY COMPARISONS WITH CRITERIA AND UPGRADIENT WATER QUALITY

The following conclusions are derived from the December 2009 data and summary statistics in Tables 3-1, 3-2, and 3-3:

- (a) For the December 2009 sampling event (Tables 3-1 and 3-2), the following parameters were detected only in background (also called upgradient) wells: nickel, selenium, 1,1,1-trichloroethane, benzene, bromodichloromethane and chemical oxygen demand.

**TABLE 3-1. SUMMARY OF PARAMETER CONCENTRATIONS IN LANDFILL MONITORING WELLS
FOR THE DECEMBER 2009 MONITORING EVENT**

Parameter	Downgradient Wells			Upgradient Wells			MCL ⁽¹⁾
	HL-90-1	HL-99-2	HL-99-3	HL-06-1	HL-94-1	MPC-5	
pH (s.u.)	7.4	7.4	7.4	7.1	7.6	7.1	NA
Specific Conductance (µmhos/cm)	1210	954	935	1260	939	2810	NA
Sulfate	140	130	160	150	89	640	NA
Chloride	94	40	42	38	16	25	NA
Nitrate+Nitrite as N	8.1	7.0	8.1	3.83	2.81	13.4	10
Iron (Dissolved)	0.06	<0.03	0.15	<0.03	<0.03	1.5	0.3 ⁽²⁾
Nickel (Dissolved)	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.10
Selenium (Dissolved)	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	0.05
1,1,1-Trichloroethane	<0.001	<0.001	<0.001	0.0054	<0.001	<0.001	0.2
1,1-Dichloroethane	0.0023	0.0030	0.0023	<0.001	<0.001	<0.001	NA
Benzene	<0.001	<0.001	<0.001	<0.001	<0.001	0.0011	0.005
Bromodichloromethane	<0.001	<0.001	<0.001	<0.001	0.0021	<0.001	0.010
Chloroform	<0.001	0.0017	0.0020	<0.001	0.015	<0.001	0.07
Cis-1,2-Dichloroethene	0.0015	<0.001	<0.001	<0.001	<0.001	<0.001	0.07
Dichlorodifluoromethane	<0.001	0.0015	<0.001	<0.001	<0.001	<0.001	1.0
Tetrachloroethene (PCE)	0.0079	0.0076	0.0068	<0.001	<0.001	<0.001	0.005
Trichloroethene (TCE)	0.0015	0.0015	0.0011	<0.001	<0.001	<0.001	0.005
Cyanide (Total)	<0.005	<0.005	0.027	<0.005	<0.005	4.45	0.2
Chemical Oxygen Demand (COD)	<1	<1	<1	<1	2	30	NA

Concentrations are in mg/L, except as indicated.

NM = not measured

(1) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies.

NA indicates no MCL has been promulgated.

(2) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

Values in **bold** exceed the MCL.

**TABLE 3-2. COMPARISON OF DOWNGRAIDENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS
AND MCLs FOR THE DECEMBER 2009 SAMPLING EVENT**

Parameter	December 2009 Downgradient Well Concentrations (mg/L) (1)						Comparison Values (mg/L)				
	D.F. ⁽³⁾	Min.	Mean ⁽⁴⁾	Median	Max.	Max. Location	Background / Upgradient Wells ⁽²⁾				MCL ⁽⁵⁾
							D.F. ⁽³⁾	Mean ⁽⁴⁾	Median	Max.	
pH (s.u.)	3/3	7.4	7.4	7.4	7.4	NA	3/3	7.3	7.1	7.6	NA
Specific Conductance (µmhos/cm)	3/3	935	1033	954	1210	HL-90-1	3/3	1669.7	1260	2810	NA
Sulfate	3/3	130	143	140	160	HL-99-3	3/3	293.0	150	640	NA
Chloride	3/3	40	<u>59</u>	<u>42</u>	94	HL-90-1	3/3	26.3	25	38	NA
Nitrate+Nitrite as N	3/3	7.0	7.7	8.1	8.1	HL-99-3	3/3	6.7	3.83	13.4	10
Iron (Dissolved)	2/3	<0.03	0.08	0.06	0.15	HL-99-3	1/3	0.52	<0.03	1.5	0.3 ⁽²⁾
Nickel (Dissolved)	0/3	<0.01	<0.01	<0.01	<0.01	NA	1/3	0.01	<0.01	0.01	0.10
Selenium (Dissolved)	0/3	<0.005	<0.005	<0.005	<0.005	NA	1/3	0.005	<0.005	0.005	0.05
1,1,1-Trichloroethane	0/3	<0.001	<0.001	<0.001	<0.001	NA	1/3	0.0025	<0.001	0.0054	0.2
1,1-Dichloroethane	3/3	<u>0.0023</u>	<u>0.0025</u>	<u>0.0023</u>	<u>0.003</u>	HL-99-2	0/3	<0.001	<0.001	<0.001	NA
Benzene	0/3	<0.001	<0.001	<0.001	<0.001	NA	1/3	0.0010	<0.001	0.0011	0.005
Bromodichloromethane	0/3	<0.001	<0.001	<0.001	<0.001	NA	1/3	0.0014	<0.001	0.0021	0.010
Chloroform	2/3	<0.001	0.0016	0.0017	0.002	HL-99-3	1/3	0.0057	<0.001	0.0150	0.07
Cis-1,2-Dichloroethene	1/3	<0.001	<u>0.0012</u>	<0.001	<u>0.0015</u>	HL-90-1	0/3	<0.001	<0.001	<0.001	0.07
Dichlorodifluoromethane	1/3	<0.001	<u>0.0012</u>	<0.001	<u>0.0015</u>	HL-99-2	0/3	<0.001	<0.001	<0.001	1.0
Tetrachloroethene (PCE)	3/3	0.0068	0.0074	0.0076	0.0079	HL-90-1	0/3	<0.001	<0.001	<0.001	0.005
Trichloroethene (TCE)	3/3	<u>0.0011</u>	0.0014	<u>0.0015</u>	<u>0.0015</u>	HL-99-2	0/3	<0.001	<0.001	<0.001	0.005
Cyanide (Total)	1/3	<0.005	0.0123	<0.005	0.027	HL-99-3	1/3	1.5	<0.005	4.45	0.2
Chemical Oxygen Demand (COD)	0/3	<1	<1	<1	<1	NA	2/3	11.0	2	30	NA

(1) Downgradient wells are: HL-90-1, HL-99-2, HL-99-3.

(2) Background / Upgradient wells are: HL-06-1, HL-94-1, MPC-5.

(3) Detection frequency (D.F.), i.e. the number of detections over the total number of samples analyzed for that parameter.

(4) Means calculated using the detection limit for non-detected sample results.

(5) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies.

NA indicates no MCL has been promulgated.

(6) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

Values in **bold** exceed the MCL. Underlined values exceed the maximum background/upgradient concentration.

**TABLE 3-3. COMPARISON OF DOWNGRAIDENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS
AND MCLs FOR ALL SAMPLING EVENTS TO DATE**

Parameter	Period of Record Downgradient Well Concentrations (mg/L) ⁽¹⁾						Comparison Values (mg/L)				
	D.F. ⁽³⁾	Min.	Mean ⁽⁴⁾	Median	Max.	Max. Location	Background / Upgradient Wells ⁽²⁾				MCL ⁽⁵⁾
							D.F. ⁽³⁾	Mean ⁽⁴⁾	Median	Max.	
pH (s.u.)	70/70	7.1	7.49	7.5	7.9	HL-90-1	88/88	7.40	7.4	7.9	NA
Specific Conductance (µmhos/cm)	68/68	178	911.5	914	1170	HL-90-1	87/87	1442	890	4170	NA
Sulfate	70/70	103	131.8	130	170	HL-99-3	88/88	340.5	121.5	1980	NA
Chloride	70/70	29	39.9	39	66	HL-90-1	87/88	31.2	25	195	NA
Nitrate+Nitrite as N	64/64	4.5	7.7	7.7	10.7	HL-99-3	83/83	13.1	7.3	73	10
Iron (Dissolved)	20/69	<0.03	0.090	<0.03	0.94	HL-99-3	41/88	0.39	<0.03	3.14	0.3 ⁽⁶⁾
Nickel (Dissolved)	0/63	<0.01	<0.01	<0.01	<0.01	NA	20/85	0.011	<0.01	0.05	0.10
Selenium (Dissolved)	1/69	<0.005	0.0050	<0.005	0.006	HL-99-3	23/90	0.0054	<0.005	0.01	0.05
1,1,1-Trichloroethane	44/122	<0.001	0.0017	<0.001	<u>0.0074</u>	HL-90-1	11/94	0.0013	<0.001	0.0057	0.2
1,1-Dichloroethane	118/122	<0.001	<u>0.0025</u>	<u>0.0025</u>	<u>0.0052</u>	HL-99-3	0/94	<0.001	<0.001	<0.001	NA
Benzene	0/122	<0.001	<0.001	<0.001	<0.001	NA	24/94	0.0061	<0.001	0.077	0.005
Bromodichloromethane	0/122	<0.001	<0.001	<0.001	<0.001	NA	9/94	0.0012	<0.001	0.0048	0.010
Chloroform	118/122	<0.001	0.0023	0.0022	0.0055	HL-90-1	71/94	0.0056	0.003	0.037	0.07
Cis-1,2-Dichloroethene	8/115	<0.001	<u>0.0010</u>	<0.001	<u>0.0017</u>	HL-90-1	0/89	<0.001	<0.001	<0.001	0.07
Dichlorodifluoromethane	97/122	<0.001	<u>0.0023</u>	<u>0.0017</u>	<u>0.015</u>	HL-90-1	0/94	<0.001	<0.001	<0.001	1.0
Tetrachloroethene (PCE)	120/122	<0.001	<u>0.0083</u>	<u>0.0070</u>	<u>0.024</u>	HL-99-3	0/94	<0.001	<0.001	<0.001	0.005
Trichloroethene (TCE)	90/122	<0.001	<u>0.0014</u>	<u>0.0012</u>	<u>0.0032</u>	HL-99-3	0/94	<0.001	<0.001	<0.001	0.005
Cyanide (Total)	35/69	<0.005	0.012	<0.005	0.058	HL-99-2	25/89	1.3	<0.005	10.9	0.2
Chemical Oxygen Demand (COD)	41/68	<1	3.2	2	25	HL-99-3	66/88	14.1	7.0	75	NA

(1) Downgradient wells are: HL-90-1, HL-99-2, HL-99-3.

(2) Background / Upgradient wells are: 83-6, HL-06-1, MPC-5, HL-94-1,.

(3) Detection frequency (D.F.), i.e. the number of detections over the total number of samples analyzed for that parameter.

(4) Means calculated using the detection limit for non-detected sample results.

(5) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies.
NA indicates no MCL has been promulgated.

(6) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

Values in **bold** exceed the MCL. Underlined values exceed the maximum background/upgradient concentration.

Parameters detected in only downgradient wells include: 1,1-dichloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, tetrachloroethene (PCE), and trichloroethene (TCE).

- (b) Parameters historically detected only in background wells (Table 3-3) include: benzene and bromodichloromethane. Parameters historically detected in only downgradient wells include: 1,1-dichloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, PCE, and TCE.
- (c) Nitrate, iron, cyanide, and PCE were reported at concentrations exceeding MCL criteria in the December 2009 sampling event (Tables 3-1 and 3-2). The MCLs for nitrate, and cyanide were both exceeded in a single upgradient well (MPC-5); the MCL for PCE was exceeded in three downgradient wells (HL-90-1, HL-99-2 and HL-99-3); the secondary MCL (based on aesthetic properties rather than human health standards) for iron was exceeded in a single upgradient well (MPC-5).
- (d) Historically in these wells, nitrate, iron, benzene, PCE, and cyanide have been reported at concentrations exceeding MCL criteria (Table 3-3). The MCL for PCE has been exceeded in only downgradient wells; nitrate and iron have exceeded their MCLs in both upgradient and downgradient wells and the MCLs for benzene and cyanide have been exceeded in only upgradient wells. The December 2009 data is generally consistent with these trends.
- (e) Nitrate was detected in all of the December 2009 samples. The MCL of 10.0 mg/L was exceeded in one sample collected in upgradient well (MPC-5). Monitoring well MPC-5 showed an increasing trend from 1998 through 2005 reaching a maximum of 73.0 mg/L. Since then, there has been some decrease in the nitrate concentration in this well and it is currently at a level of 13.4 mg/L. Discussions with MPC representatives revealed that an attempt to remediate cyanide (from a historic coal gasification plant that was operated just east of the landfill) through oxidation may have inadvertently increased nitrate concentration in area groundwater. This pilot program was shut down when these adverse affects became apparent.
- (f) Metals concentrations in groundwater samples have historically been low (typically below laboratory detection limits). Iron was detected in downgradient wells HL-90-1

and HL-99-3 and in upgradient well MPC-5; nickel and selenium were detected in only upgradient well MPC-5 during December 2009 monitoring (Table 3-1). The detected metal concentrations were all at or near their detection limits except for iron in downgradient well HL-99-3 (0.15 mg/L) and upgradient well MPC-5 (1.5 mg/L) compared to a detection limit of 0.03 mg/L. Iron exceeded the secondary MCL of 0.3 mg/L (based on aesthetic properties such as taste, odor and staining rather than human health standards) in MPC-5. Iron has historically fluctuated at MPC-5 with concentrations ranging from approximately 0.2 mg/L to 4 mg/L (based on data collected from December 1995 through December 2009).

(g) During the December 2009 sampling event, several volatile organic compounds (VOCs) were detected in samples from downgradient wells, but not in samples from background wells (1,1-dichloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, PCE, and TCE). PCE was the only VOC to exceed its MCL in downgradient wells (HL-90-1, HL-99-2 and HL-99-3). 1,1,1-Trichloroethane, benzene, and bromodichloromethane were detected only in background wells; none of these compounds exceeded its MCL in upgradient wells. Chloroform was the only VOC detected in samples from both downgradient and background wells. All detections of chloroform were well below the MCL of 0.07 mg/L.

(h) Cyanide was detected in a single downgradient well (HL-99-3) and a single upgradient well (MPC-5) during the December 2009 sampling event. Cyanide concentrations in upgradient well MPC-5 (4.05 mg/L) exceeded the MCL (0.2 mg/L). Previous sampling events have shown that cyanide is present at concentrations ranging from approximately 0.77 to 11 mg/L (based on data collected from June 1995 through December 2009) in upgradient well MPC-5. Historically, downgradient detections of cyanide have been well below the MCL indicating that elevated cyanide levels are not attributable to the Helena Landfill (Table 3-3). As noted previously, a coal gasification plant was historically operated east of the landfill site and could be a source of residual cyanide in groundwater upgradient of the landfill.

3.2 INTER-WELL PREDICTION INTERVAL ANALYSIS

An inter-well prediction interval analysis was used to test for statistically significant differences between background and compliance well concentrations for selected parameters (those above the detection limit in any of the monitoring wells for the December 2009 sampling event). Combining all historical data for the background wells, the Shapiro-Francia Test of Normality was performed for each parameter to determine if the distribution of the background data was normal. All non-detect values were evaluated at one-half the detection limit. If the data was determined not to be normally distributed, the data set was re-evaluated using a natural log (ln) transformation of the data to determine if the data was ln-normally distributed. Inter-well parametric prediction intervals were used when the background data were normally or ln-normally distributed. In cases where the background data were not normally or ln-normally distributed, a non-parametric prediction limit was used. Results of the prediction interval test are summarized in Table 3-4. Documentation for each of these statistical tests used is included in Appendix B of this report.

As shown on Table 3-4, 1,1-dichloroethane, cis-1,2-dichloroethane, dichlorodifluoromethane, PCE, and TCE have statistically greater concentrations in downgradient wells than upgradient wells.

3.3 TREND ANALYSIS

In addition to evaluating the chemical concentrations in upgradient and downgradient wells around the landfill for the December 2009 sampling event, it is also important to evaluate concentration trends of key constituents over time. Using the Mann-Kendall test, statistical testing for trends was performed for each downgradient exceedance of its respective inter-well prediction interval as discussed in Section 3.2. All non-detect values were evaluated as zero to prevent the detection of false trends when parameters are detected at concentrations less than the reporting limit or when the reporting limits have changed over time. The results of these analyses are summarized in Table 3-5. Documentation for these statistical tests is included in Appendix B of this report. Cis-1,2-dichloroethane is showing increasing trends in HL-90-1; according to National Primary Drinking Water Regulations, cis-1,2-

TABLE 3-4. RESULTS OF INTER-WELL PREDICTION INTERVAL TESTS

Parameter	Background Wells		Downgradient Wells		
	Distribution ⁽¹⁾	Prediction Limit ⁽²⁾	HL-90-1	HL-99-2	HL-99-3
pH (s.u.)	Normal (99%)	6.57-8.22	7.4	7.4	7.4
Specific Conductance (μ mhos/cm)	Non-Normal	4118	1210	954	935
Sulfate	Non-Normal	1876	140	130	160
Chloride	Non-Normal	166	94	40	42
Nitrate+Nitrite as N	Ln-Normal (99%)	174	8.1	7.0	8.1
Iron (Dissolved)	Non-Normal	2.97	0.06	<0.03	0.15
Nickel (Dissolved)	Non-Normal	0.033	<0.01	<0.01	<0.01
Selenium (Dissolved)	Non-Normal	0.010	<0.005	<0.005	<0.005
1,1,1-Trichloroethane	Non-Normal	0.0054	<0.001	<0.001	<0.001
1,1-Dichloroethane	ND	0.001	0.0023	0.0030	0.0023
Benzene	Non-Normal	0.066	<0.001	<0.001	<0.001
Bromodichloromethane	Non-Normal	0.0042	<0.001	<0.001	<0.001
Chloroform	Non-Normal	0.036	<0.001	0.0017	0.0020
Cis-1,2-Dichloroethene	ND	0.001	0.0015	<0.001	<0.001
Dichlorodifluoromethane	ND	0.001	<0.001	0.0015	<0.001
Tetrachloroethene (PCE)	ND	0.001	0.0079	0.0076	0.0068
Trichloroethene (TCE)	ND	0.001	0.0015	0.0015	0.0011
Cyanide (Total)	Non-Normal	10.6	<0.005	<0.005	0.027
Chemical Oxygen Demand (COD)	Non-Normal	67.2	<1	<1	<1

(1) Normality was calculated using the Shapiro-Francia test.

Norm (X%) = data normally distributed at X% level of significance.

Ln-Norm (X%) = data ln-normally distributed at X% level of significance.

Non-Norm = data not normally or ln-normally distributed at 95% or 99% level of significance.

ND = all background data below detection limits. Value shown is the detection limit.

(2) Prediction limits calculated as follows:

Normal or ln-normal distribution: parametric prediction interval (99% one-sided, two-sided for pH)

Non-normal distribution: non-parametric prediction interval (99% one-sided, two-sided for pH)

ND: any detectable concentrations in compliance wells are considered significant.

Bold values indicate statistically significant results.

NA - not analyzed

dichloroethane is formed as a breakdown product from the reductive dehalogenation of the common industrial solvents TCE and PCE. PCE is showing decreasing trends in downgradient wells. TCE is showing increasing and decreasing trends in downgradient wells. 1,1-Dichloroethane is showing increasing trends in downgradient wells; this compound is a breakdown product of 1,1,1-trichloroethane, historically found primarily in wells upgradient of the Helena landfill.

TABLE 3-5. RESULTS OF MANN-KENDALL TREND ANALYSES

Parameter	HL-90-1	HL-99-2	HL-99-3
1,1-Dichloroethane	No Trend	Increasing	No Trend
Cis-1,2-Dichloroethane	Increasing		
Dichlorodifluoromethane		No Trend	
Tetrachloroethene (PCE)	Decreasing	No Trend	Decreasing
Trichloroethene (TCE)	Decreasing	Increasing	No Trend

Note: Grayed boxes did not have downgradient exceedances of the respective inter-well prediction interval and therefore a trend analysis was not performed.

3.4 TEMPORAL CONCENTRATION PLOTS

This report focuses on concentration trends for PCE and nitrate because they are the only constituents consistently exceeding their MCLs in downgradient monitoring wells. PCE was also the focus of the Corrective Measures Assessment for the landfill (Hydrometrics, 1995).

In an attempt to reduce concentrations of PCE in compliance well HL-90-1, the City installed a groundwater extraction system in the spring of 2000. This treatment system involves pumping wells HL-99-1, HL-99-2 and HL-99-3 to intercept PCE leaving the landfill, and treating the water to remove VOCs prior to land application on Bill Roberts Golf Course. These wells have been included in groundwater monitoring events along with compliance well HL-90-1 to evaluate the progress of this new groundwater extraction system.

Trends in PCE concentrations over time for the past ten years for the downgradient monitoring wells are shown on Figure 3-1. PCE concentrations exceeded the MCL value of 0.005 mg/L in all three downgradient monitoring wells for December 2009.

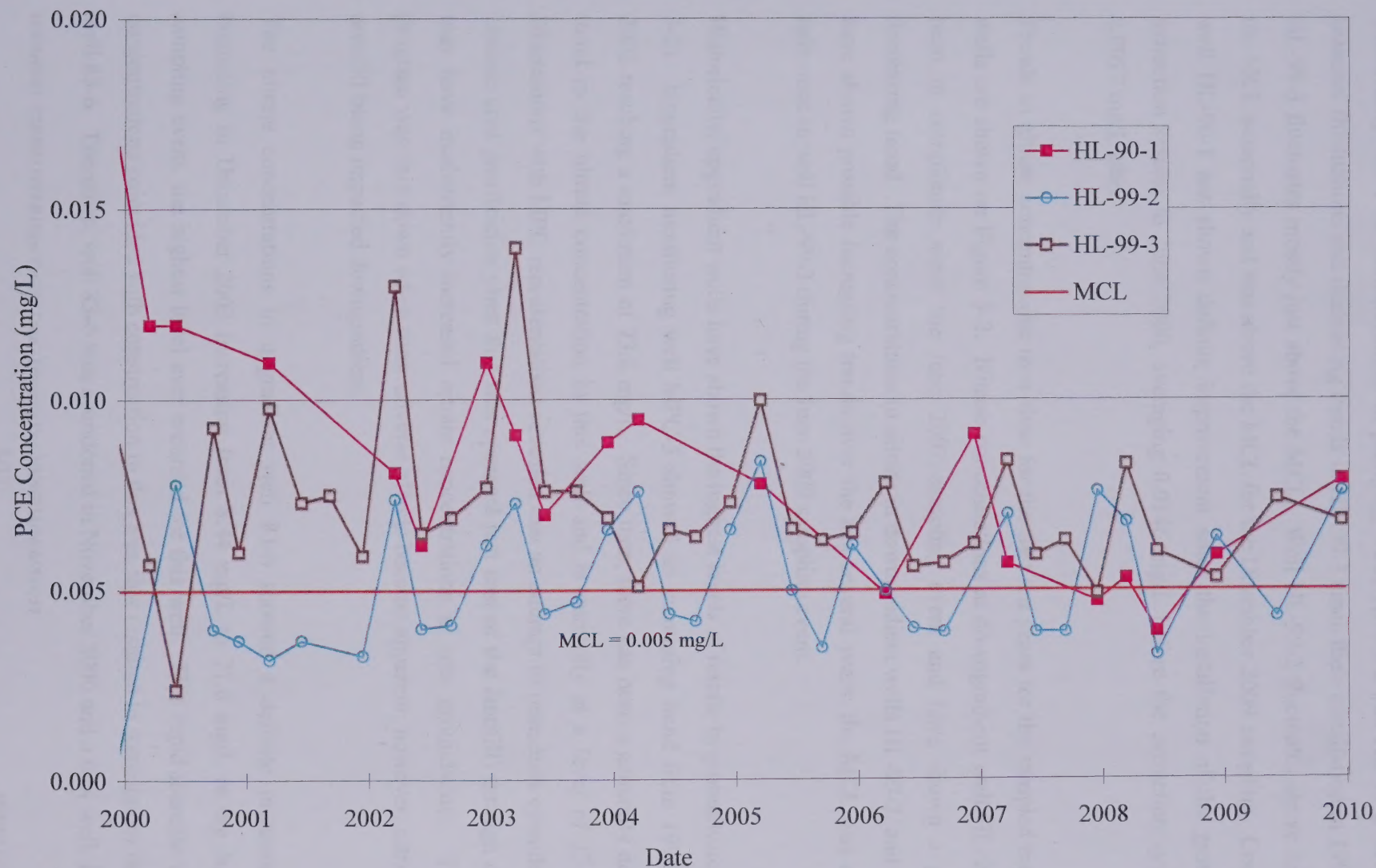


Figure 3-1. Temporal Trends in Tetrachloroethene Concentrations at Selected Downgradient Wells

Historically, the PCE concentrations in pumping wells HL-99-2 and HL-99-3 have shown seasonal fluctuations and decreasing trends in HL-99-3 since their installation in 1999. Well HL-99-3 fluctuates mostly just above the MCL. Well HL-99-2 fluctuates above and below the MCL seasonally and was above the MCL for the December 2009 sampling. Compliance well HL-90-1 has shown definite improvement since the installation of the groundwater extraction system in June 2000, averaging 0.0146 mg/L before the extraction system and 0.0077 mg/L after.

Trends in nitrate concentrations over time for the past ten years for the sampled monitoring wells are shown on Figure 3-2. Nitrate concentrations at downgradient well HL-90-1 have been in compliance since the June 2002 sampling event and have shown a generally decreasing trend. The concentrations in nitrate in downgradient wells HL-99-2, and HL-99-3 have shown possible increasing trends over the last several years; the MCL was exceeded only once in well HL-99-3 during the June 2009 sampling event.

Historically, upgradient wells have shown the highest levels of nitrate in groundwater (Figure 3-2). Upgradient monitoring well MPC-5 showed an increasing trend from 1998 through 2005 reaching a maximum of 73.0 mg/L. Since then, there has been a generally decreasing trend in the nitrate concentration in this well and is currently at a level of 13.4 mg/L. Discussions with MPC representatives revealed that an attempt to remediate cyanide (from a historic coal gasification plant that was operated just east of the landfill) through oxidation may have inadvertently increased nitrate concentrations in area groundwater. This pilot program was shut down when these adverse affects became apparent; however, nitrate levels are still being impacted downgradient.

The nitrate concentrations in upgradient well 83-6 showed a definite increasing trend beginning in December 2003 increasing from 8.44 mg/L to 71.6 mg/L in the June 2006 sampling event, the highest level ever recorded for this well. This rapid increase in nitrate concentrations coincided with construction in this area that resulted in some minor damage to well 83-6. Therefore, well 83-6 was abandoned in November 2006 and a new well, HL-06-1,

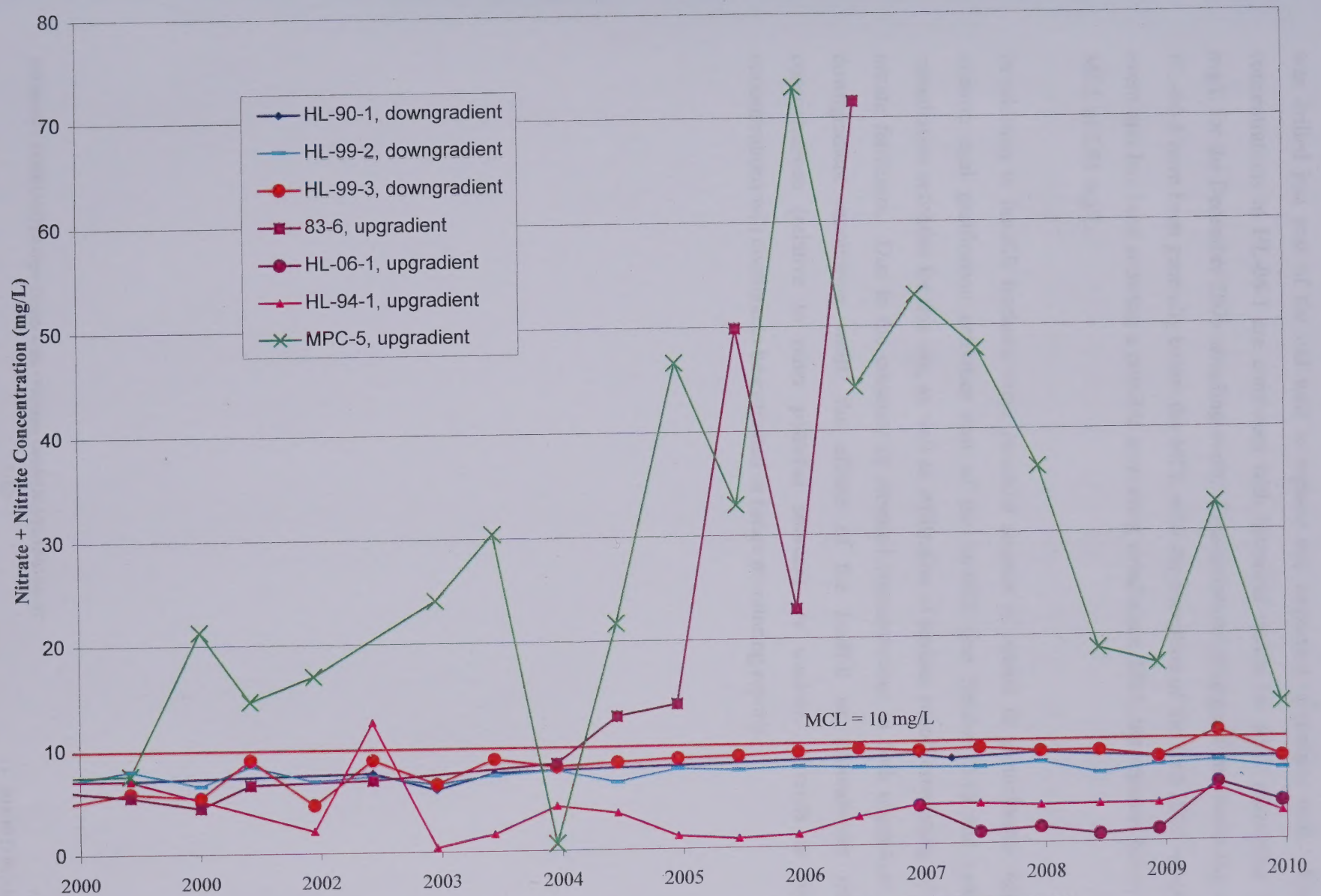


Figure 3-2. Temporal Trends in Nitrate Concentrations at Selected Wells

was drilled just east of the old well to replace this important upgradient well. Nitrate concentrations in HL-06-1 are consistent with historical results for 83-6, measuring 3.83 mg/L for the December 2009 sampling event. Concentrations in upgradient monitoring well HL-94-1 have been generally below the MCL with the exception of the June 2002 sampling event and has been showing a possible increasing trend since 2005, but remains below the MCL at 2.81 mg/L.

In addition to landfill leachate, other potential sources of nitrate in groundwater include historic coal gasification activities east of the landfill (see Section 3.1) and cyanide remediation activities for this site, as well as infiltration of surface runoff containing soluble nitrate fertilizers. Due to the presence of elevated concentrations in both upgradient and downgradient monitoring wells, the effects of the landfill on groundwater nitrate concentrations (relative to other potential sources) are unclear. Trends in nitrate concentrations will continue to be evaluated in future monitoring reports.

4. DOMESTIC WELL DATA EVALUATION

Two domestic wells were also sampled during the December 2009 sampling event. For wells 5 and 16, the only VOCs reported at concentrations above the detection limit were chloroform and tetrachloroethene; all detections were below their respective MCLs. The concentrations for all parameters for both wells were similar to concentrations measured in these wells during the June 2009 sampling event. Trends in PCE concentrations over the last ten years for the sampled domestic wells are shown on Figure 4-1. Both of these wells are used only for irrigation and all homeowners of these domestic wells have been connected to the City water supply.

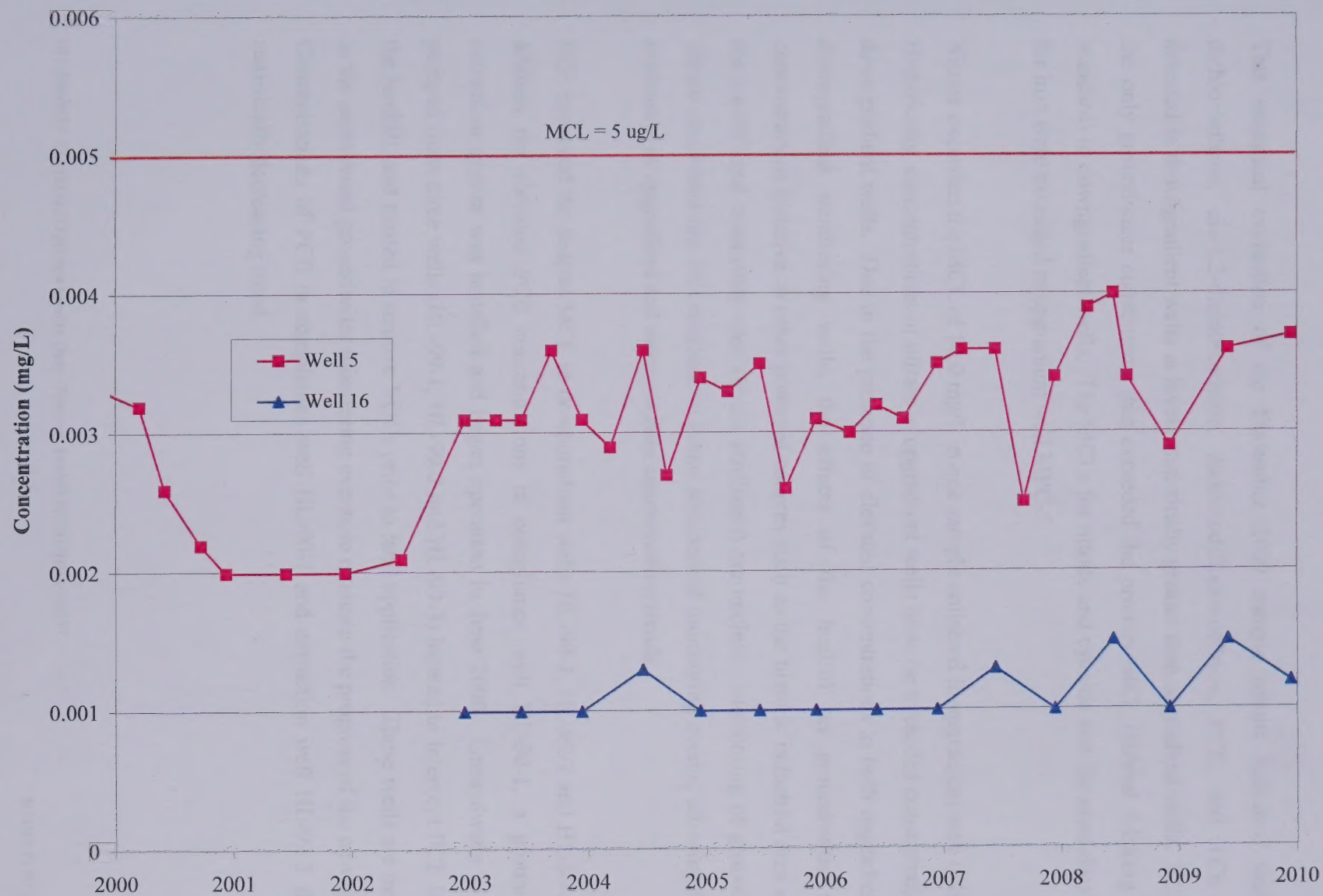


Figure 4-1. Temporal Trends in PCE Concentrations in Domestic Wells

5. SUMMARY AND CONCLUSIONS

This statistical evaluation of the December 2009 sample results indicated that 1,1-dichloroethene, cis-1,2-dichloroethene, dichlorodifluoromethane, PCE, and TCE were detected in downgradient wells at levels statistically greater than upgradient wells. PCE was the only groundwater constituents that exceeded the primary MCL (federal drinking water standard) in downgradient wells. The MCLs for nitrate and cyanide and the secondary MCL for iron were exceeded in upgradient well MPC-5.

Nitrate exceeded the MCL of 10.0 mg/L in one sample collected in upgradient well (MPC-5). Historically, concentrations of nitrate in upgradient wells have far exceeded concentrations in downgradient wells. Due to the presence of elevated concentrations in both upgradient and downgradient monitoring wells, the effects of the landfill on groundwater nitrate concentrations (relative to other potential sources such as the historic industrial area east of the landfill and commonly used nitrate fertilizers) are unclear. Monitoring of groundwater nitrate concentrations will continue in future semiannual monitoring events, allowing further evaluation of upgradient and downgradient concentration trends.

PCE exceeded the federal MCL in downgradient wells HL-90-1, HL-99-2 and HL-99-3. To address the elevated PCE concentrations in compliance well HL-90-1, a groundwater extraction system was installed and began operation in June 2000. Groundwater is being pumped from three wells (HL-99-1, HL-99-2 and HL-99-3) located to intercept PCE leaving the landfill, and treated to remove VOCs prior to land application. These wells are included in the semiannual groundwater monitoring events to evaluate the progress of the new system. Concentrations of PCE in compliance well HL-90-1 and extraction well HL-99-3 show a statistically decreasing trend.

6. REFERENCES

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APPENDIX A

DATA VALIDATION REPORT
(APPENDICES SUBMITTED IN DIGITAL FORMAT)

DATA VALIDATION REPORT

CITY OF HELENA LANDFILL

Groundwater Samples Collected in

**December 2009
(Semi-Annual Sampling)**

Prepared by
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February 2010

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GLOSSARY OF TERMS

CCB.....	Continuing Calibration Blank
CCV	Continuing Calibration Verification
CLP	Contract Laboratory Program
CRDL.....	Contract Required Detection Limit
FAA	Flame Atomic Absorption
GFAA.....	Graphite Furnace Atomic Absorption
HGAA.....	Hydride Generation Atomic Absorption
ICB.....	Initial Calibration Blank
ICP	Inductively Coupled Plasma
ICV.....	Initial Calibration Verification
IDL	Instrument Detection Limit
LCS	Laboratory Control Sample
MSA.....	Method of Standard Additions
PB.....	Preparation Blank
PRDL	Project Required Detection Limit
QAPP	Quality Assurance Project Plan
QC.....	Quality Control
RPD.....	Relative Percent Difference
RSD.....	Relative Standard Deviation
SOW.....	Statement of Work
TDS.....	Total Dissolved Solids

SUMMARY

Laboratory analysis for groundwater samples collected for the December 2009 sampling event as part of the City of Helena Landfill have been reviewed and validated. This review has been in accordance with the "Revised Sampling and Analysis Plan; City of Helena Landfill; Groundwater, Surface Water, and Landfill Gas Monitoring Activities" (Hydrometrics, March 2008). All samples were analyzed at Energy Laboratories in Helena, Montana.

Data results are qualified when associated field quality control samples have not met validation criteria. Not all quality control deficiencies are equally serious and some may not have any practical impact on the usefulness of the data. A summary of quality control violations found in this validation follows:

Violations involving field quality control samples:

- The chain of custody indicated a sample temperature of -0.9°C upon check in, this is deemed as unacceptable as the control limit range is 4°C ($\pm 2^{\circ}$). All samples were noted as received either all or partially frozen when checked in.
- In sample HL-0912-104 the volatile organic analysis bottle had a large sized air bubble when checked in at the laboratory which was noted on the sample check in receipt.
- Sample HL-0912-106 was preserved in the field for nutrients but did not meet the <2.0 requirement of the laboratory when received. The laboratory took corrective action when adding the sulfuric acid (H_2SO_4) to the sample at checkin and noting it on the laboratory receipt checklist.
- Field stabilization was not performed on Sample HL-0912-105 (HL-90-1). It was noted in the field book that one bottle for volatile organics was removed from the site and the well did not recover.

Violations involving laboratory quality control samples:

- In the QA/QC Summary Report provided by Energy Laboratories, matrix spike and matrix spike duplicate review each showed one exceedance for total cyanide. However, at this level of validation, laboratory exceedances are noted but no flagging of the data occurs. Energy Laboratories flagged the samples with an S in the QA/QC summary report provided.

- It should also be noted that Energy Laboratories raised the detection limit of nitrate + nitrite as n and total cyanide due to sample matrix interference. The detection limits used for dissolved antimony and thallium were lower than the requested limits, and did not seem to impact the results.
- Energy Laboratories exceeded the holding time for pH for all samples submitted. However, as a rule holding times for laboratory pH measurements are frequently exceeded because measurements are typically not conducted “immediately”, but rather as soon as practicable. Therefore, no qualifiers are applied for lab pH holding time exceedances.
- It should be noted that Energy Laboratories used a different method than stated in the work plan on the following parameters: pH, SC, cyanide, and several dissolved metals. However, no associated data was flagged because the methods used are considered comparable to stated methods in work plan.
- All Dichlorodifluoromethane results were flagged with a C in all laboratory results due to a Continuing Calibration Verification sample exceeding the QC advisory limits. However, at this level of validation, laboratory exceedances are noted but no flagging of the data occurs.

Deviations from the prescribed quality control procedures and/or exceedances of quality control limits have been noted, and results have been flagged in the database. The data quality objectives for accuracy and precision were met, as 100 percent of the field quality control sample results were within control limits and 99 percent of the laboratory quality control samples were within limits. The frequency requirements of 10 percent submittal of blanks, duplicates, control standards and spikes were met. The recommended project completeness goal, acceptance of 90 percent of the results as valid, has also been met as no results have been rejected as a result of this data review.

Further discussion of data quality objectives is in Section 12 of the data validation report. All tables are in Appendix 1: data validation codes and definitions are listed in Table 1; and a historical comparison is in Table 2. A database printout of this sampling event is located in Appendix 2. The Hydrometrics field notes are in Appendix 3. Energy Laboratories Analytical Reports are located in Appendix 4.

DATA VALIDATION REPORT

1. INTRODUCTION

This validation applies to organic analytes for 24 water samples collected for the City of Helena Landfill semi-annual monitoring project during the December 2009 sampling event. The total number of samples included: thirteen field observations, one field duplicate, one field DI blank, and one trip blank.

All samples were submitted for volatile organic analyses, and select samples were submitted for inorganic analyses (metals and wet chemistry) as follows:

SITE CODE	SAMPLE NUMBER	WATER LEVEL	FIELD PARAMETERS ¹	METALS AND COMMONS ²	VOLATILES METHOD 8260 ³
I-1	HL-0912-119	X			
INF GALLERY	HL-0912-120	X			
82-3	HL-0912-112	X			
83-7	HL-0912-113	X			
EPA-1	HL-0912-114	X			
EPA-4	HL-0912-115	X			
HL-06-1	HL-0912-102	X	X	X	X
HL-90-1	HL-0912-105	X	X	X	X
HL-90-2	HL-0912-116	X			
HL-90-3	HL-0912-117	X			
HL-94-1	HL-0912-100	X	X	X	X
HL-94-1 DUP	HL-0912-101			X	X
HL-94-1R	HL-0912-123	X			
HL-94-3	HL-0912-118	X			
HL-99-1	HL-0912-111	X			
HL-99-2	HL-0912-104	X	X	X	X
HL-99-3	HL-0912-103	X	X	X	X
MPC-1	HL-0912-121	X			
MPC-2	HL-0912-122	X			
MPC-5	HL-0912-106	X	X	X	X
RES #5	HL-0912-109		X		X
RES #16	HL-0912-108		X		X
RINSBLANK	HL-0912-107			X	X
TRIP BLANK	HL-0912-109				X

- 1.) Field parameters include pH, SC, and water temperature.
- 2.) Metals and commons include those compounds listed in the first half of ARM 17.50.708 Table 1.
- 3.) Volatile organic compounds include those listed in the second half of ARM 17.50.708 Table 1.

- Validation procedures used are generally consistent with:
(Check all that apply)
 - ☒ EPA CLP National Functional Guidelines for Inorganics Data Review
 - ☒ EPA CLP National Functional Guidelines for Organic Data Review
 - ☒ Work Plan (Sampling and Analysis Plan, City of Helena Landfill Groundwater Monitoring Activities, Hydrometrics, March 2008)
- Overall level of validation:
 - ☐ Contract Laboratory Program (CLP)
 - ☒ Standard (see following notes)
 - ☐ Visual

NOTES: The review of this data includes checking all field and laboratory quality control samples; flagging for exceedances in field quality control; and calculating precision, accuracy, and completeness for both laboratory and field quality control samples.

2. DELIVERABLES

- All laboratory document deliverables were present as specified in the CLP-Statement of Work (CLP-SOW), EPA, 1993 and/or the project contract.
 - ☒ Yes
 - ☐ No
- All documentation of field procedures was provided as required.
 - ☒ Yes (see following notes)
 - ☐ No

NOTES: Sample HL-0912-106 was preserved in the field for nutrients but did not meet the <2.0 requirement of the laboratory when received. The laboratory took corrective action when adding the sulfuric acid (H₂SO₄) to the sample at checkin and noting it on the laboratory receipt checklist.

- Consistency with project requirements
 - Sampling was completed in order as stated in the SAP.
 - ☒ Yes (see following notes)
 - ☐ No

NOTES: It should be noted that the wells were not sampled in the order listed in the SAP. However, all the wells that were sampled out of order were wells that use dedicated or disposable equipment.

Also, it should be noted that the VOA bottle for sample HL-0912-104 was received by the laboratory with a large sized air bubble, this was noted by the laboratory when received at checkin.

During the field data quality review, it was noted field stabilization was not preformed on Sample HL-0912-105 (HL-90-1). A notation in the field book indicated that one bottle for volatile organics was removed from the site and the well did not recover.

3. FIELD QUALITY CONTROL SAMPLES

- **Field blanks**

Please note that the highest blank value associated with any particular analyte is the blank value used for the flagging process.

DI, trip, Rinsate, or any other field blanks have been carried out at the proper frequency.

☒ Yes

☐ No

Reported results on the field blanks are less than the contract required detection limits (CRDL) or the project required detection limits (PRDL) if project detection limits have been specified.

☒ Yes

☐ No

- **Field duplicates**

Field duplicates have been collected at the proper frequency.

☒ Yes

☐ No

Field duplicate relative percent differences (RPD's) were within the required control limits (RPD of 20 percent or less for water matrix, 35 percent or less for soil matrix). If the sample or duplicate result is less than 5 times the PRDL, the RPD criteria are not used. In these cases, the difference between the sample and the duplicate results must be within $\pm$ the PRDL for water matrix, within $\pm$ 2 times the PRDL for soil matrix.

☒ Yes

☐ No

- **Field standards**

Field standards were sent at the proper frequency

☐ Yes

☐ No

☒ NA - Not required by the work plan.

4. LABORATORY PROCEDURES

- **Laboratory procedures followed**

☐ CLP-SOW

☒ SW-846

☒ Methods for Chemical Analysis of Water and Wastes

☐ XRF Standard Operating Procedures

☐ Other

NOTES: Energy Laboratories noted on the sample receipt checklist that sulfuric acid was added to the nutrient sample HL-0912-106. This sample was preserved in the field but did not meet the <2.0 requirement of the laboratory. Laboratory staff took proper corrective action by adding the proper preservative to the sample along with noting as such in the laboratory receipt checklist. In addition, on the laboratory checklist pH was marked as unacceptable due to the addition of acid in sample HL-0912-106 but was not labeled as such on the laboratory analysis report.

- **Samples were received by the laboratory at the proper temperature**

☐ Yes
☒ No (see the following notes)

NOTES: The chain of custody indicated a sample temperature of -0.9°C upon check in, this is deemed as unacceptable as the control limit range is 4°C ($\pm 2^{\circ}$). All samples were noted as received either all or partially frozen when checked in.

- **Holding times met**

☐ Yes
☒ No (see the following notes)

NOTES: Energy Laboratories exceeded the holding time for pH for all samples submitted. However, as a rule holding times for laboratory pH measurements are frequently exceeded because measurements are typically not conducted "immediately", but rather as soon as practicable. Therefore, no qualifiers are applied for lab pH holding time exceedances.

- **Consistency with project requirements**

Analyses were carried out as requested.

☒ Yes
☐ No

Project specified methods were used.

☒ Yes (see following notes)
☐ No

NOTES: It should be noted that Energy Laboratories used a different method than stated in the work plan on the following parameters: pH, SC, cyanide, and several dissolved metals. However, no associated data was flagged because the methods used are considered comparable to stated methods in work plan.

5. DETECTION LIMITS

- **Reporting detection limits met project required detection limits (PRDL).**

☒ Yes (see following notes)
☐ No

NOTES: It should be noted that Energy Laboratories raised the reporting limit for nitrate + nitrite as n and total cyanide in samples due to sample matrix interference. The reporting limits used for dissolved antimony and thallium were lower than the requested limits, and did not seem to impact the results.

6. LABORATORY BLANKS

Please note that the highest blank value associated with any particular analyte is the blank value used for the flagging process.

- **Preparation/Method blanks**

Preparation/Method blanks were prepared and analyzed at the required frequency.

☒ Yes
☐ No

All analytes in the preparation blank were less than the CRDL (or PRDL if a project detection limit has been specified).

☒ Yes

☐ No

7. LABORATORY BLANK SPIKES

- **Blank Spikes**

Blank spikes (organics) were prepared and analyzed at the required frequency.

☒ Yes

☐ No

Blank spike recoveries were within control limits.

☒ Yes

☐ No

8. SURROGATE SPIKES

- **Surrogate Spikes**

Surrogate spikes were prepared and analyzed at the required frequency.

☒ Yes

☐ No

Surrogate spike recoveries were within control limits.

☐ Yes

☒ No (see following notes)

NOTES: All Dichlorodifluoromethane results were flagged with a C in all laboratory results due to a Continuing Calibration Verification sample exceeded the QC advisory limits.

9. MATRIX SPIKE /MATRIX SPIKE DUPLICATES (MS/MSD)

- Matrix spike samples were analyzed at the proper frequency.

☒ Yes

☐ No

Matrix spike recoveries were within control limits.

☐ Yes

☒ No (see following notes)

- Matrix spike duplicate samples were analyzed at the proper frequency.

☒ Yes

☐ No

Matrix spike duplicate RPD's were within control limits.

☐ Yes

☒ No (see following notes)

NOTES: Both matrix spike and matrix spike duplicate samples had one QC exceedance for total cyanide. At this level of validation, these exceedances are only noted and no flagging of the associated data occurs.

10. INTERPARAMETER RELATIONSHIPS

- The following relationships have been checked for all data from the December 2009 monitoring:

X Lab SC versus field SC

X Lab pH versus field pH

Lab SC versus field SC: A comparison of the field and lab SCs using a percent difference (%D) criteria for evaluation purposes, showed that none of the SC pairs exceeded the ten percent comparison criteria.

Lab pH versus field pH: A comparison of the field and lab pHs using a percent difference (%D) criteria for evaluation purposes, showed that also none of the pH pairs exceeded the ten percent comparison criteria.

11. HISTORICAL COMPARISON

Current sampling event data (December 2009) were compared to historical data (December 2005 through November 2009). The data for the December 2009 sampling event was similar to historic data.

12. DATA QUALITY OBJECTIVES

- Project data quality objectives (DQO's) met.

X Yes

 No

Accuracy

Accuracy for this project is the agreement between a measured value and a true value and is measured by the recoveries on the laboratory matrix spikes and laboratory control samples.

Accuracy for this sampling event was 99 percent.

Precision

Precision for this project is the degree of variability between duplicate measurements. Laboratory analytical variability is measured by laboratory duplicates; field duplicates are a measure of overall variability in both field sampling and laboratory techniques.

Laboratory precision was 99 percent for this sampling event.

Field precision was 100 percent for this sampling event.

Completeness

The target completeness for this project is 90 percent of the measurements valid (not rejected). This percentage is based on the number of valid measurements compared to the number of planned measurements.

Completeness for this sampling event was 100 percent.

DATA VALIDATION REPORT

Prepared by: Ericka Vallance

Reviewed by: Jodi Bingham, P.E.

REFERENCES

- Hem, J.D., 1992. Study and Interpretation of the Chemical Characteristics of Natural Water, 3rd Edition. US Geological Survey Water Supply Paper 2254.
- Hydrometrics Project Work Plan. Sampling and Analysis Plan City of Helena Landfill Groundwater Monitoring Activities, March 2008.
- U.S. Environmental Protection Agency, 1990. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition.
- U.S. Environmental Protection Agency, 1993. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. October 2004.
- U.S. Environmental Protection Agency, 1994. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. October 2004.

DATA VALIDATION AND STATISTICS
EVALUATION OF DECEMBER 2008
GROUNDWATER QUALITY DATA
CITY OF HELENA LANDFILL
APPENDIX A - DATA VALIDATION (APPENDICES ONLY)

March 2010

Hydrometrics, Inc.
Consulting Scientists and Engineers
3020 Bozeman
Helena, MT 59601
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APPENDIX B

STATISTICAL ANALYSIS REPORTS (SUBMITTED IN DIGITAL FORMAT)

Hydrometrics, Inc
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3020 Bozeman
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March 2010

APPENDIX B - STATISTICAL ANALYSIS REPORTS
CITY OF HELENA LANDFILL
EVALUATION OF DECEMBER 2008
GROUNDWATER QUALITY DATA

CD-ROM

CD-ROM





